ME 418 – Quality in Manufacturing

ISE 320 – Quality Control and Industrial Statistics

LECTURE 08

THE 7 MANAGEMENT AND PLANNING TOOLS – THE 7 NEW QUALITY TOOLS

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What are the New Seven Quality Tools

In 1976, the Union of Japanese Scientists and Engineers (JUSE) saw the need for tools to promote innovation, communicate information and successfully plan major projects.

A team researched and developed the seven new quality control tools, to be used with the 7 basic quality tools.

Often called the seven management and planning (MP) tools, or simply the seven management tools.

The New Seven Quality Tools (The Seven Management and Planning Tools)

The seven new tools, listed in an order that moves from abstract analysis to detailed planning, are:

1. **Affinity Diagram**
2. **Relations Diagram**
3. **Tree Diagram**
4. **Matrix Diagram**
5. **Arrows Diagram**
6. **Process Decision Program Chart**
7. **Prioritization Matrix- Matrix Data Analysis**

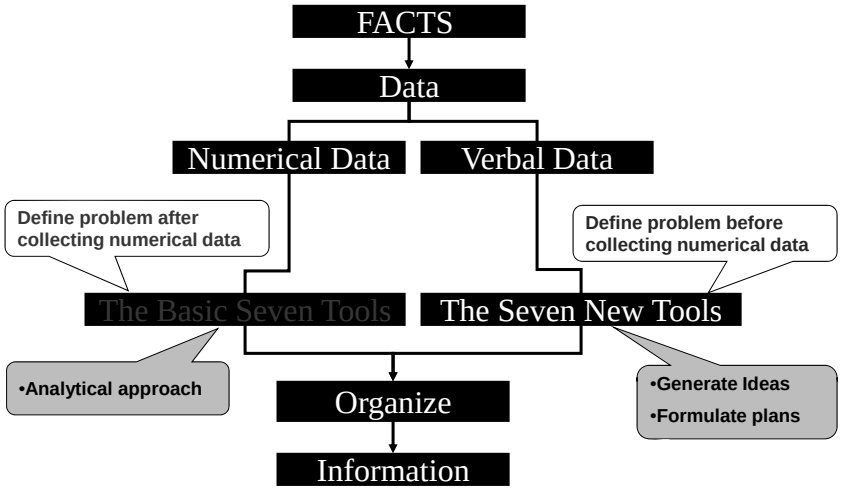
New Seven Q.C. Tools

Developed to organize verbal data diagrammatically.

Basic 7 tools effective for data analysis, process control, and quality improvement (numerical data)

Used together increases TQM effectiveness

Relation Between New Seven Q.C. Tools and Basic Seven Tools



Benefits of Incorporating New Seven Q.C. Tools

Organize verbal data
Generate ideas
Improve planning
Eliminate errors and omissions
Explain problems intelligibly
Secure full cooperation between teams
Persuade powerfully

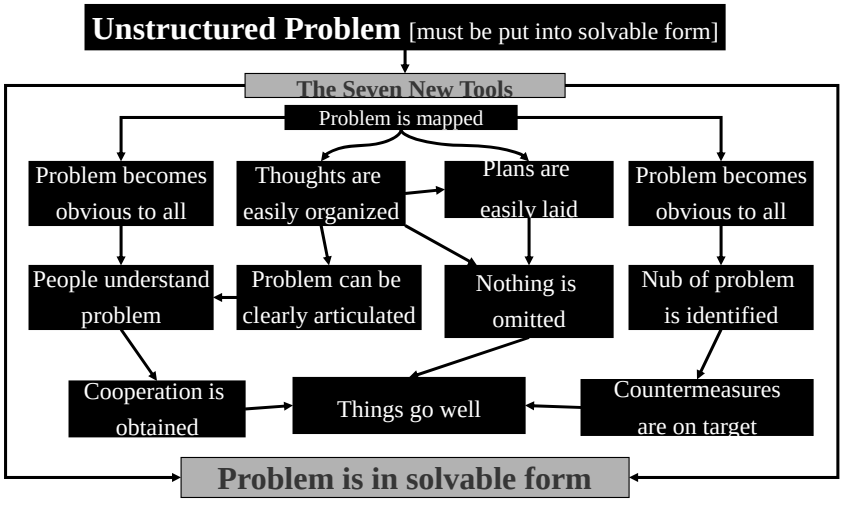
- Enhanced Keys to Organizational Reform
- Assess situations from various angles
- Clarify the desired situation
- Prioritize tasks effectively
- Proceed systematically
- Anticipate future events
- Change proactively
- Get things right first time

Benefits of Incorporating New Seven Q.C. Tools

Five Objectives of Organizational Reform which will establish a Culture that:

Identifies problems
Gives importance to planning
Stresses the importance of the process
Prioritizes tasks
Encourages everyone to think systematically

Benefits of Incorporating New Seven Q.C. Tools


Unstructured Problem [must be put into solvable form]
The Seven New Tools
Problem is mapped
Problem becomes obvious to all
Thoughts are easily organized
Plans are easily laid
Problem becomes obvious to all
People understand problem
Problem can be clearly articulated
Nothing is omitted
Nub of problem is identified
Cooperation is obtained
Things go well
Countermeasures are on target
Problem is in solvable form

The New Seven Q.C. Tools and Organizational Change through TQM

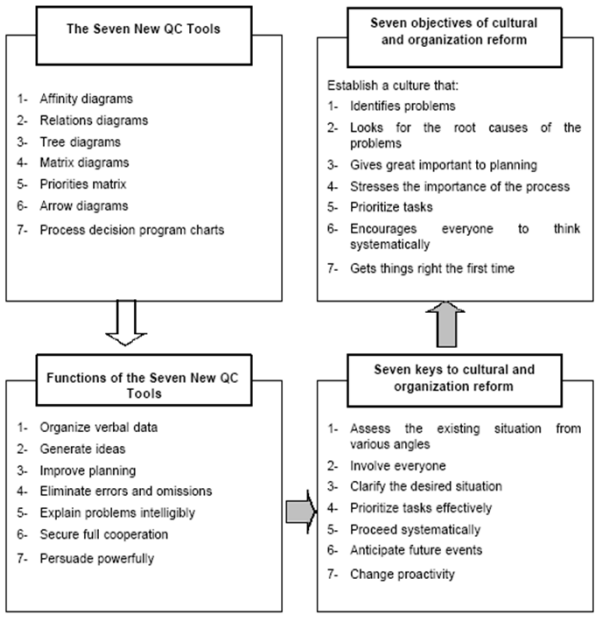

The Seven New QC Tools
1- Affinity diagrams
2- Relations diagrams
3- Tree diagrams
4- Matrix diagrams
5- Priorities matrix
6- Arrow diagrams
7- Process decision program charts
Seven objectives of cultural and organization reform
Establish a culture that:
1- Identifies problems
2- Looks for the root causes of the problems
3- Gives great important to planning
4- Stresses the importance of the process
5- Prioritize tasks
6- Encourages everyone to think systematically
7- Gets things right the first time
Functions of the Seven New QC Tools
1- Organize verbal data
2- Generate ideas
3- Improve planning
4- Eliminate errors and omissions
5- Explain problems intelligibly
6- Secure full cooperation
7- Persuade powerfully
Seven keys to cultural and organization reform
1- Assess the existing situation from various angles
2- Involve everyone
3- Clarify the desired situation
4- Prioritize tasks effectively
5- Proceed systematically
6- Anticipate future events
7- Change proactivity

Figure 3 The Seven New QC Tools and organizational Reform through TQM

Tool 1 – The Affinity Diagram

Gathers large amounts of verbal data (ideas, opinions, issues); then Organizes the data into groups based on natural relationship; and

Makes it feasible for further analysis and to find a solution to the problem.

Why use the Affinity Diagram?

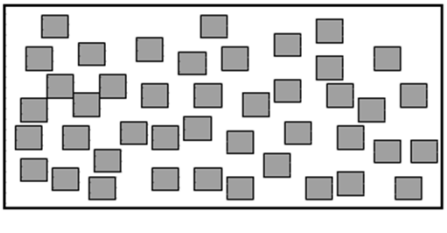
To allow a team to creatively generate a large number of ideas/issues and then organize and summarize natural groupings among them to understand the essence of a problem and propose solutions.

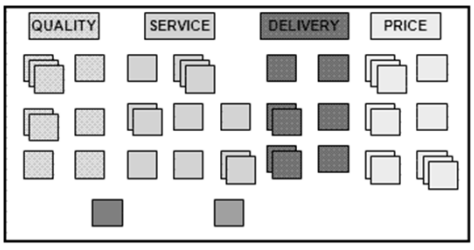
How to construct an Affinity Diagram

- Select the topic to be analyzed
- Use brainstorming to collect verbal data and ideas
- Write each item on separate data card
- Spread out all cards on table or stick them on a board
- Move data cards into groups of similar themes (natural affinity for each other)
- Combine statements on data cards to new Affinity statement
- Make new card with Affinity statement
- Continue to combine until less than 5 groups
- Draw the final Affinity Diagram for the problem discussed

Affinity Diagram

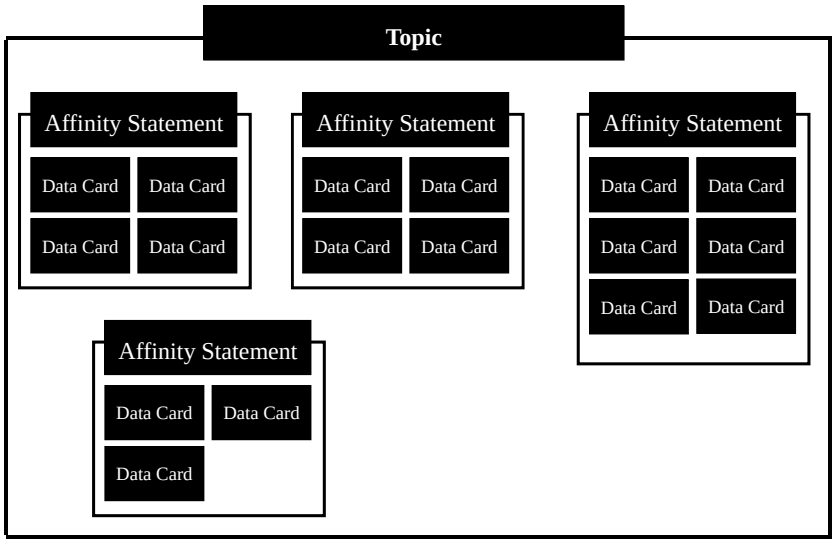
Verbal data generated by brainstorming and written on cards





Organized cards through natural relations = **Affinity diagram**

Affinity Diagram



Affinity Diagram Example

Customer service is sub-standard

Figure 3

Why is customer service sub-standard?
Too much turnover
Untrained staff
No standard systems
There aren't enough phone lines
Staff aren't compensated enough
There's no measurement for what is and what isn't good service
Staff morale is low
Staff feel unappreciated
Not enough management support

Figure 5

Why is customer service sub-standard?
Human Resource Issues
Lack of standard processes and measurement
Workplace culture
Resources and tools
Too much turnover
No standard systems
Not enough management support
There aren't enough phone lines
Untrained staff
There's no measurement for what is and what isn't good service
Staff feel unappreciated
Staff aren't compensated enough
Staff morale is low

Affinity Diagram

incidents of customer's complaints due to poor product quality

Personnel are not Quality Conscious

- Operators are making mistakes
- Inspectors do not check the quality during production
- Workers do not care about the product quality
- No quality training

Poor Subcontractor Material

- Raw material is sub-standard
- No incoming inspection
- Sub-contractors are not chosen properly
- Poor quality of raw materials
- Cheaper raw materials are being used

Defective products are reaching the customers

- Actual standards are not available
- Final inspection is very poor
- No calibration of the equipment
- Inspection methods are very poor
- Defective products not segregated
- Inspection & testing equipment are old & inaccurate

Employees Absenteeism

- Any other operator is asked to do the job when the actual operator is absent
- Leave rules are very relaxed
- There are not enough skilled operators
- There are no alternative operators
- No incentives for good attendance

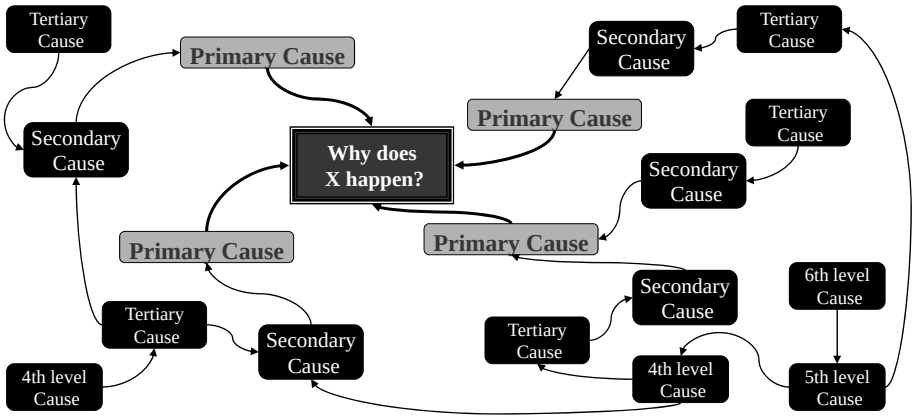
Tool N. 2 : Relations Diagrams

For Finding Solutions Strategies by Clarifying Relationships with Complex Interrelated Causes. To allow a team to systematically identify, analyze, and classify the cause and effect relationships that exist among all critical issues.

- Useful at planning stage for obtaining perspective on overall situation.
- Facilitates consensus among team
- Assists to develop and change people's thinking
- Enables priorities to be identified accurately

Relations Diagram

Makes the problem recognizable by clarifying the relationships among causes



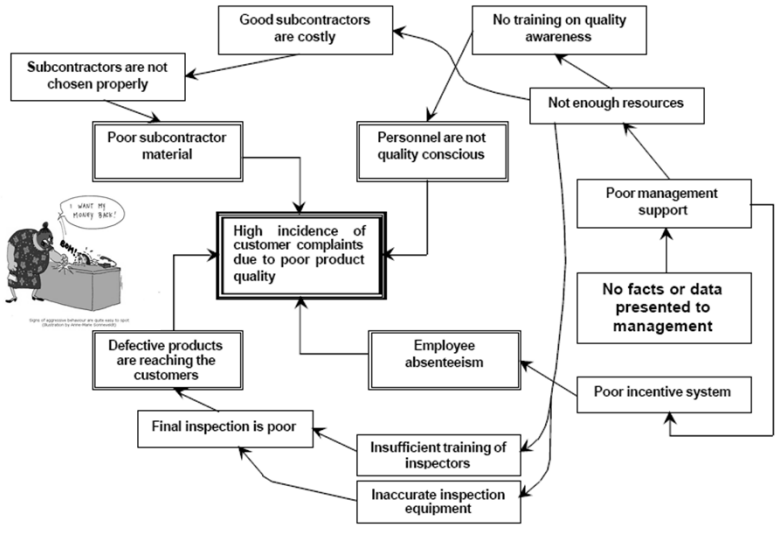
Constructing a Relations Diagram

- Express the problem in form of “Why isn’t something happening?”
- Each member lists 5 causes affecting problem
- Write each item on a card
- Discuss info collected until everyone understands it thoroughly
- Move cards into similar groups
- Asking why, explore the cause-effect relationships, and divide the cards into primary, secondary and tertiary causes

Constructing a Relations Diagram

- Connect all cards by these relationships
- Further discuss until all possible causes have been identified
- Review whole diagram looking for relationships among causes
- Connect all related groups
- Next, complete the diagram

Example: Relations Diagram


Good subcontractors are costly
No training on quality awareness
Subcontractors are not chosen properly
Not enough resources
Poor subcontractor material
Personnel are not quality conscious
Poor management support
High incidence of customer complaints due to poor product quality
No facts or data presented to management
Defective products are reaching the customers
Employee absenteeism
Poor incentive system
Final inspection is poor
Insufficient training of inspectors
Inaccurate inspection equipment

Tool N. 3: Tree Diagram

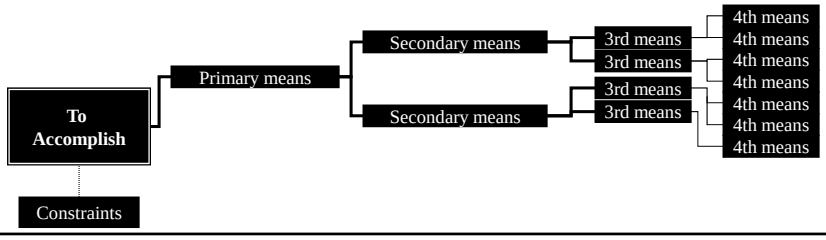
For Systematically Pursuing the Best Strategies for Attaining an Objective

- Develops a succession of strategies for achieving objectives
- Reveals methods to achieve the results.
- Also known as Systematic diagrams or Dendrograms

Tree Diagrams

Advantages of Tree Diagrams

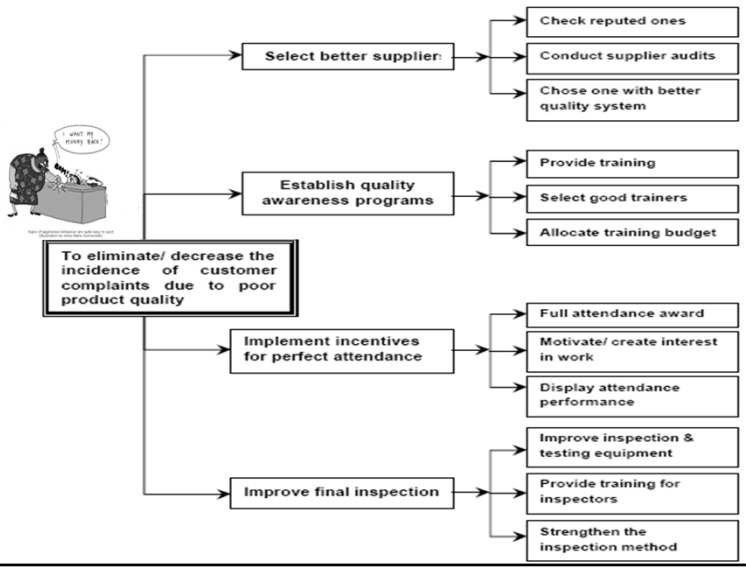
- Systematic and logical approach is less likely that items are omitted
- Facilitates agreement among team
- Are extremely convincing with strategies



Constructing a Tree Diagram

- Write Relations Diagram topic (Objective card)
- Identify constraints on how objective can be achieved
- Discuss means of achieving objective (primary means, first level strategy)
- Take each primary mean, write objective for achieving it (secondary means)
- Continue to expand to the fourth level
- Review each system of means in both directions (from objective to means and means to objective)
- Add more cards if needed
- Connect all levels
- Next, complete the diagram

Tree Diagram : Example of Customer Complaints due to poor quality


To eliminate/ decrease the incidence of customer complaints due to poor product quality
Select better supplier
Check reputed ones
Conduct supplier audits
Chose one with better quality system
Establish quality awareness programs
Provide training
Select good trainers
Allocate training budget
Implement incentives for perfect attendance
Full attendance award
Motivate/ create interest in work
Display attendance performance
Improve final inspection
Improve inspection & testing equipment
Provide training for inspectors
Strengthen the inspection method

Tool 4 - Matrix Diagrams

For Clarifying Problems by "Thinking Multidimensionally"

To allow a team or individual to systematically identify, analyze, and rate the presence and strength of relationships between two or more sets of information.

Matrix Diagrams

- Consists of a two-dimensional array to determine location and nature of problem
- Discovers key ideas by relationships represented by the cells in matrix.
- Enable data on ideas based on extensive experience
- Clarifies relationships among different elements
- Makes overall structure of problem immediately obvious
- Combined from two to four types of diagrams, location of problem is clearer.

Constructing a Matrix Diagram

- Write final-level means from Tree diagram forming vertical axis
- Write in Evaluation categories (efficacy, practicability, and rank) on horizontal axis.
- Examine final-level means to identify whom will implement them
- Write names along horizontal axis
- Label group of columns as “Responsibilities”
- Label right-hand end of horizontal axis as “Remarks”
- Examine each cell and insert the appropriate symbol:
- Efficacy: O=good, ▲=satisfactory, X=none
- Practicability: O=good, ▲=satisfactory, X=none

Constructing a Matrix Diagram (cont.)

- Determine score for each combination of symbols, record in rank column.
- Examine cells under Responsibility Columns, insert double-circle for Principal and single-circle for Subsidiary
- Fill out remarks column and record meanings of symbol
- Next, complete the diagram

Central Statistical Office Participation Matrix
Supervision (is responsible over the delegated authority)
Control (takes decision)
Partnership (gives approval)
Inform (gets informed)
Activities/Actors
Chairman
Technical officer
Deputy (data collection)
Director (production)
Director (dissemination)
Director (project)
Deputy (data processing)
Director (research)
Director (economy)
Director (training)
Director (computers)
Director (documentation)
Director (programme)
Director (finance)
1. Sufficient resources obtained
1.1 Overall development plan presented
1.1.1 Preparation of project proposal
1.1.2 Discuss the proposal with other ministries
1.1.3 Discuss the proposal with donors
1.1.4 Co-ordinate with the Min. of Planning to have the final proposal
1.2 Efficient co-ordination mechanism operational
1.2.1 Put and execute co-ordination plan
1.2.2 Appoint a co-ordinator
1.2.3 Determine the job description
1.2.4 Train the staff to achieve their duties
2. Data collection improved
2.1 Recurrent data collection improved
2.1.1 Statistical data are directly disseminated to the concerned users
2.2 Data collection for surveys, census, etc. is improved
2.2.1 Training for data collectors
2.2.2 Improving the financial incentive system
3. Data input from data providers improved
3.1 Train & qualify skills of Stat. Units in statistics and computers
3.2 Improve the quality of skills in CSO branches
3.3 Clarify questionnaires, definitions and instructions
3.4 Involve Stat. Units in field work
3.5 Evaluate data from providers
3.6 Seminar for data users
Overall supervision

Example of Matrix Diagram:

Customer Complaints due to poor product quality

Means	Efficacy	Practicability	Rank	Responsibility: President	Production	Quality Control	HRD	Finance	Purchasing
Check reputed ones	≺	□	3		;	;			T
Conduct supplier audits	□	≺	2		;	T			;
Check with better quality system	≺	≺	4		;	T			;
Provide training on quality awareness	□	□	1		;	;	T		
Select good trainers	≺	≺	4		;	;	T		
Allocate training budget	≺	□	3	;			;	T	
Full attendance award	□	□	1	T			;	;	
Motivate/ create interest in the work	≺	≺	4		;	;	T		
Display attendance performance	≺	□	3		;	;	T		
Improve inspection & testing equipment	≺	□	3	;		T		;	;
Provide training for inspectors	□	≺	2			T	;		
Strengthen the inspection method	≺	□	3		;	T			

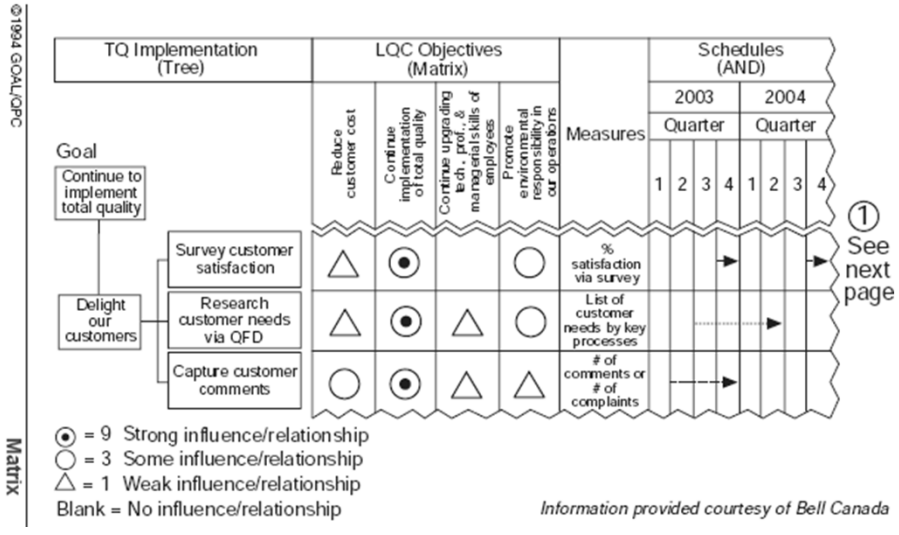
Efficacy/ practicability

	Scoring Key
□ Good	□ □ = 1 ≺ □ = 3
≺ Satisfactory	□ ≺ = 2 ≺ ≺ = 4

Responsibility

T Principal
; Subsidiary

Example of Matrix Diagram:



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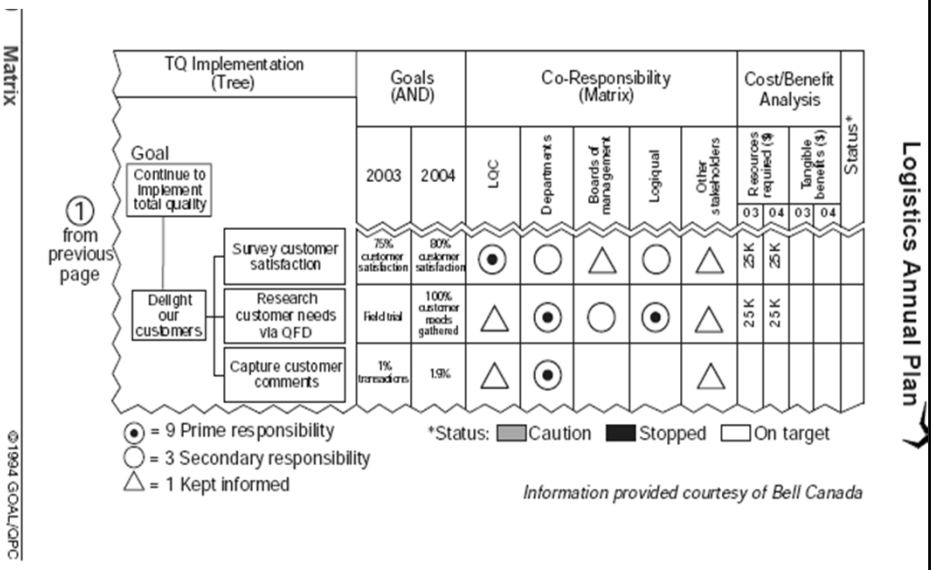


Tool 5 - Arrows Diagram

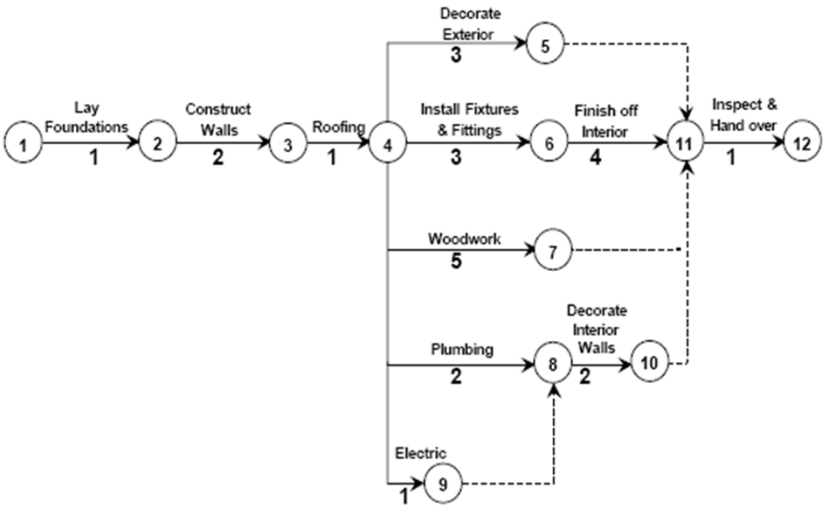
For Working Out Optimal Schedules and Controlling Them Effectively

- Shows relationships among tasks needed to implement a plan
- Network technique using nodes for events and arrows for activities
- Allows overall task to viewed and potential snags to be identified before work starts
- Leads to discovery of possible improvements
- Makes it easy to monitor progress of work
- Deals promptly with changes to plan
- Improves communication among team

Constructing an Arrow Diagram

- From strategies on Tree diagram, select one (Objective of Arrow Diagram)
- Identify constraints to Objective
- List all activities necessary to achieving Objective
- Write all essential activities on separate cards
- Organize cards in sequential order of activities
- Remove any duplicate activities
- Review order of activities, find sequence with greatest amount of activities
- Arrange parallel activities
- Examine path, number nodes in sequence from left to right
- Record names and other necessary information
- Next, complete the diagram

Arrow Diagram: Example of building a room.



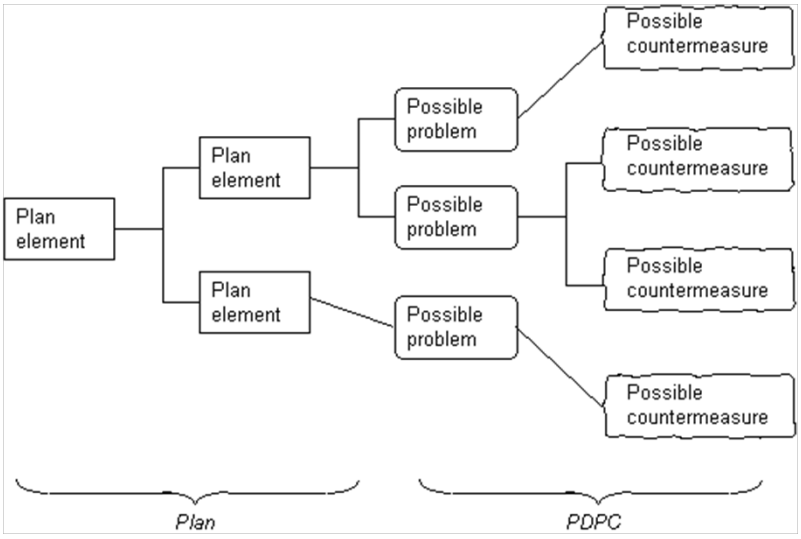
Tool 6 - Process Decisions Program Charts (PDPC)

PDPCs are used for planning the activities needed to solve problem when information is incomplete or the situation is fluid and hard to forecast.

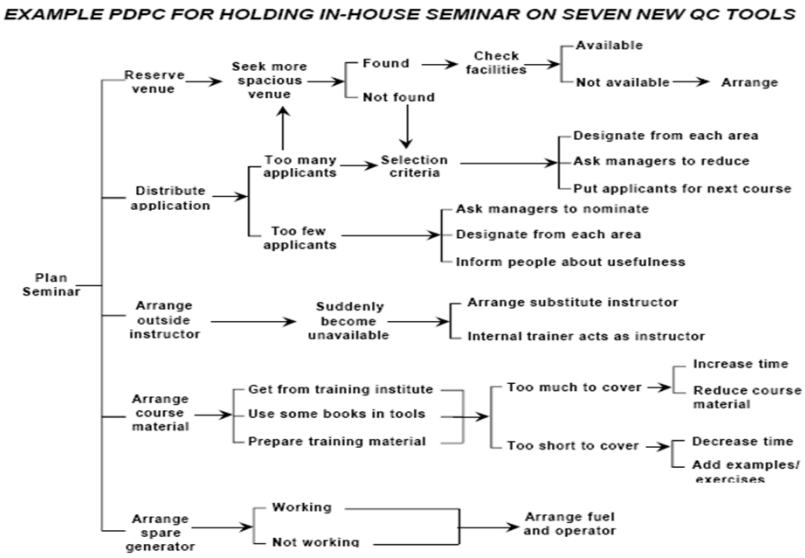
Examples include planning an R & D project, mapping out countermeasure against long-term chronic problems, and planning a sales campaign.

A PDPC consists of a series of steps linked in sequence. Its goal is to depict the events and contingencies likely to occur when progressing from a starting point to one or more final outcomes

Process Decisions Program Chart



Process Decisions Program Chart



Tool 7 - Prioritization Matrix
(Matrix Data Analysis)

- Technique quantifies and arranges data presented in Matrix
- Based solely on numerical data.
- Finds indicators that differentiate and attempt to clarify large amount of information.

Prioritization Matrix is used by teams to narrow down options through a systematic approach of comparing choices by selecting, weighting, and applying criteria.

Constructing a Prioritization Matrix

- Determine your goal, your alternatives, and criteria for decision
- Place selection in order of importance
- Apply percentage weight to each option
- Sum individual ratings to establish overall ranking (Divide by number of options for average ranking)
- Rank order each option with respect to criterion (Average the rankings and apply a completed ranking)
- Multiply weight by associated rank in Matrix (in example, 4 is best, 1 is worst)
- Result is Importance Score
- Add up Importance Scores for each option
- Rank order the alternatives according to importance

Prioritization Matrix – Example from manufacturing

Criteria →	Customer Acceptance (most important)	Cost	Reliability	Strength (least important)	Importance Sum Score	Option Ranking
Options ↓						
Design A						
Percentage weight	.40	.30	.20	.10		
Rank	4	3	3	1		
Importance score	1.6	.90	.60	.10	3.2	1 (tie)
Design B						
Percentage weight	.30	.40	.10	.20		
Rank	3	4	1	2		
Importance score	.90	1.6	.10	.40	3.0	2
Design C						
Percentage weight	.25	.25	.25	.25		
Rank	1	2	4	3		
Importance score	.25	.50	1	.75	2.5	3
Design D						
Percentage weight	0.3	.10	.20	.40		
Rank	3	1	3	4		
Importance score	.90	.10	.60	1.6	3.2	1 (tie)
Sum of weights	1.25	1.05	.75	.95		
Average weight	.31	.26	.19	.24		
Criterion Ranking	1	2	4	3		

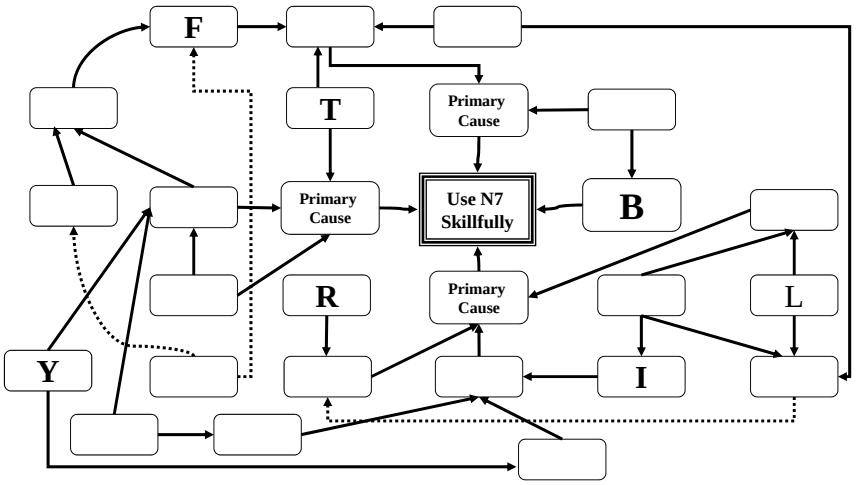
Practical Application of New Seven Q.C. Tools

"Abilities Required for Applying New Seven QC Tools"
Cause Statements (hints are in yellow)

A	Interpret data clearly	N	Understand seriousness of problem
B	Select appropriate tool	O	Think flexibly from various standpoints
C	Think systematically	P	Obtain appropriate verbal data
D	Give opinions	Q	Expose core of problem
E	Know what the problem is	R	Communicate well
F	Extract necessary information	S	Accurately understand real problem
G	Collect reliable verbal data	T	Have excellent intuition
H	Think multidimensionally	U	See to heart of problem
I	Obtain facts	V	Select appropriate type of verbal data
J	Interpret analytical results	W	Think in terms of word-based diagram
K	Generate ideas	X	Express genuine thoughts
L	Know that distorted data is useless	Y	Hear and respect other's opinions
M	Grasp overall pictured	Z	Generate highly accurate verbal data

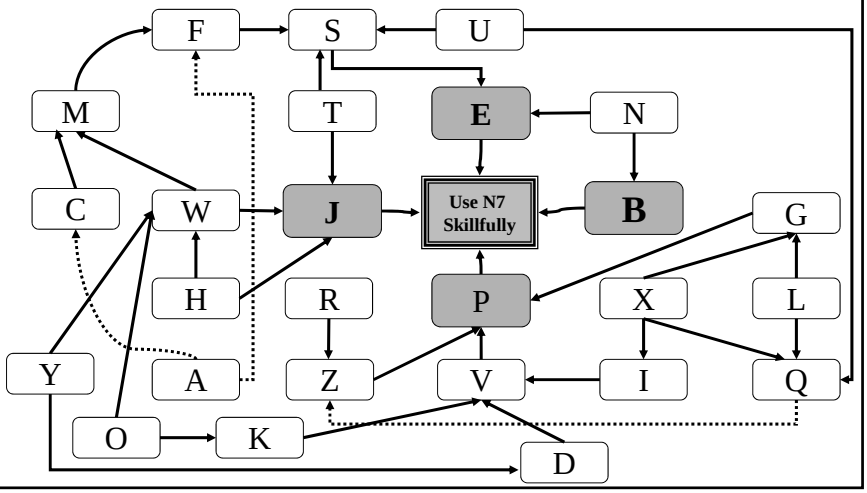
Practical Application of New Seven Q.C. Tools

"Abilities Required for Applying New Seven QC Tools"



***Source**: Foster, S., Managing Quality (Upper Saddle River, NJ: Prentice Hall, 2001)*

Solution for ”Abilities Required for Applying New Seven QC Tools”



Summary
New Seven Quality Tools

Benefits of New Seven Q.C. Tools

1- Provide Training in Thinking
2- Raise People’s Problem Solving Confidence
3- Increase People’s Ability to Predict Future Events

Roles of New Seven Q.C. Tools

1- Express verbal data diagrammatically
2- Make information visible
3- Organize information intelligibly
4- Clarify overall picture and fine details
5- Get more people involved

Additional Readings

Foster, Thomas. Managing Quality. An Integrative Approach. Upper Saddle River : Prentice Hall, 2001.

"http://quality.dlsu.edu.ph/tools/tool_chart.html

Aichouni, M., Practical Guide to Continuous Process Improvement Using the Seven New Tools for Management and Planning, SQC Series, Issue 4, ISSBN-978-603-90163-8, Al-Ashab Publishing, Riyadh, 2012.

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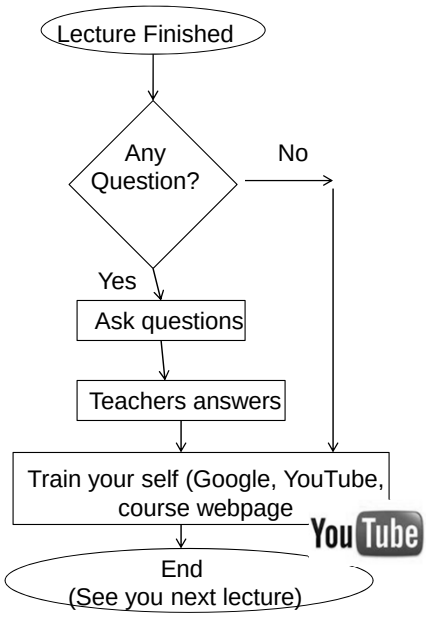
YouTube

Conclusion

"**Quality** truly **begins** with **education** and **ends** with **education**",

K. Ishikawa (1990).



What can be Improved in the College of Engineering ?